Geophysical Research Abstracts
Vol. 20, EGU2018-2052, 2018
EGU General Assembly 2018

Coastal waves in Sagami Bay, Japan under storm condition

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In this study long-term (21 years) variations of significant wave height (Hs) during 1994-2014 are investigated by utilizing high–resolution (∼1 km) hindcast wave data at Hiratsuka tower location 1 km off Hiratsuka in Sagami Bay, Japan. The wave data are extracted from a hindcast wave model based on NOAA WAVEWATCH III. The hindcast system has several components: Pacific, Offshore, Japan, and Coastal models. A downscaling technique is applied to obtain high-resolution (∼1 km) estimates from ∼5 km resolution Japan model, intermediate-resolution (∼20 km) Offshore model, and relatively coarse-resolution (∼60 km) Pacific model. The wave data from the Coastal model shows that several high wave events occurred at Hiratsuka tower location (in 21 years data, five times Hs exceeded 6 m and two times Hs exceeded 7 m). However, the highest wave with Hs 8.56 m occurred in 2012. These high waves were generated under storm conditions (or under typhoon). Recently, the Sagami Bay experienced another severe typhoon (typhoon number 21, given name is 'Lan') during October 15-23, 2017. The maximum wind speed was ∼51 ms-1 and the minimum pressure was 915 hPa. After the typhoon passage, the Hiratsuka tower was severely damaged. The tower recorded Hs data until 20171023:04 JST and thereafter it stopped measuring the wave height. The Hs measured at the last time was 7.25 m. There was no information on further wave growth. In order to investigate wave parameters during the typhoon passage, a high–resolution coastal wave model was set up based on WAVEWATCH III and SWAN models. The SWAN model consists of two components. The outer domain model uses regular grid and is configured with ∼1 km horizontal resolution, whereas the nested domain uses unstructured grid and its resolution varies from ∼10 m to ∼500 m. Spectral boundary conditions for the SWAN outer domain are obtained from a ∼5 km resolution WAVEWATCH III model. The models were forced by 0.5 deg resolution three hourly winds obtained from the Global Forecast System (GFS), which is a weather forecast model of NCEP. In a comparison of Hs between models and tower data, it is found that the agreement is reasonably good. Particularly, the peak wave height and its timing are well captured by the models. The peak wave height from WAVEWATCH III and SWAN models are comparable (7.22 m vs. 7.17 m). Results from numerical simulation reveal that Hs did not grow higher than 7.22 m at Hiratsuka tower location. It is apparent that Hs of the order of 7 m can cause severe damages to offshore platforms. The damages in the Hiratsuka tower were probably caused by such high waves. Prior sea state information of wave height is of great importance for the maintenance and safety of an offshore platform. Therefore, a wave forecast model might be useful for predicting high waves during an extreme event such as a storm or a typhoon.